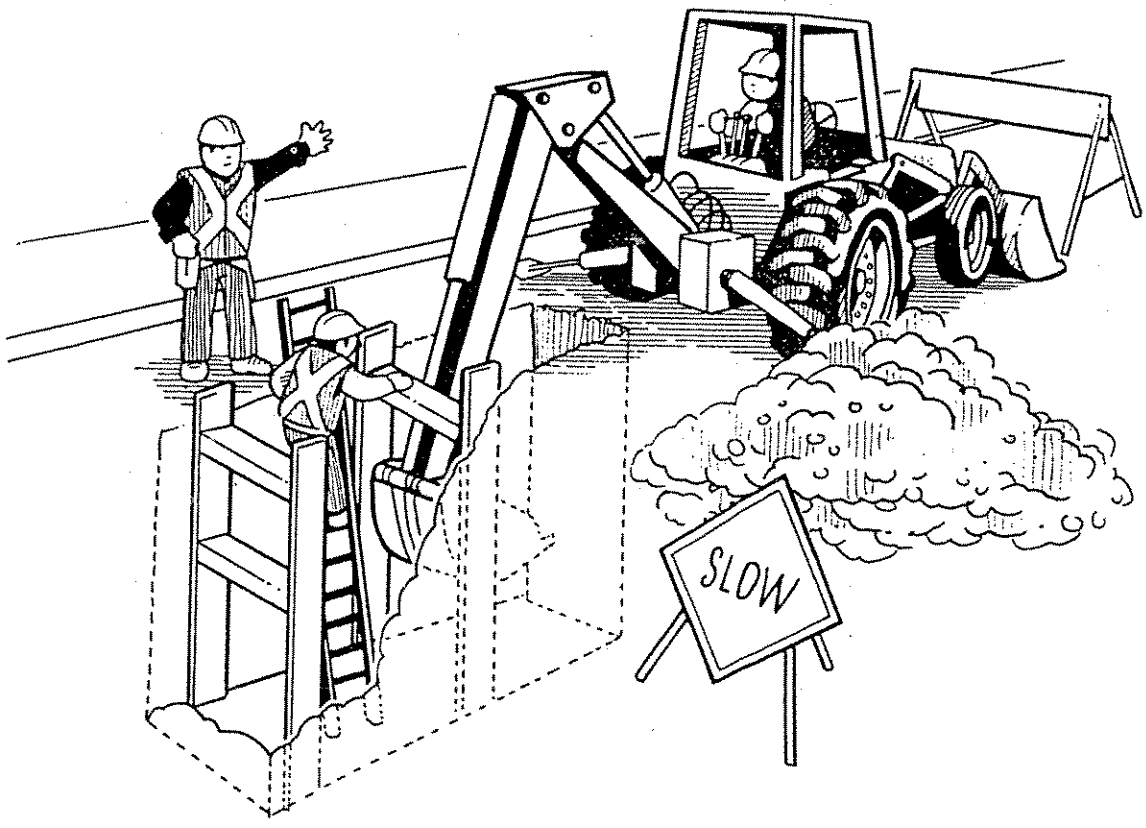
APPENDIX - C

EXCAVATION GUIDELINES.

GUIDELINES

FOR EXCAVATION WORK



Manitoba Labour

INTRODUCTION

This guideline provides a standard for proper sloping and shoring of trenches and excavations. It is intended to give excavation contractors and workers practical information relating to the requirements of the regulations pertaining to excavation work.

This guideline contains general information about excavation work. For specific regulatory requirements regarding excavation work please consult the regulations adopted under the Workplace Safety and Health Act.

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945-3446

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PART I

DEFINITIONS

Deep Foundation means a foundation unit that provides support for a building by transferring loads either by end bearing to soil or rock at considerable depth below the building, or by adhesion or friction or both, in the soil or rock in which it is placed.

Excavation means a man-made cavity or depression in the earth's surface formed by earth removal, and includes a trench, deep foundation, tunnel, shaft, or open excavation, but does not include borrow pits, gravel pits and quarries, unless specified by a safety and health officer.

Open Excavation means an excavation where the width is equal to or greater than the depth.

Pile or Caisson means a slender deep foundation unit made of materials such as wood, steel or concrete or combination thereof, which is either premanufactured and placed by driving, jacking, jetting or screwing, or cast-in-place in a hole formed by driving, excavation or boring.

Professional engineer means a person who is a member of the Association of Professional Engineers of Manitoba and registered as a professional engineer under The Engineering Profession Act or who, being a non-resident, is in possession of a subsisting license granted under The Engineering Profession Act.

Shaft means a vertical or inclined opening excavated below ground level.

Sheathing means a continuous row of wood or steel sheets in close contact to provide a tight wall to resist the pressure of the walls of an excavation.

Shoring means a construction procedure used specifically to maintain the stability of the walls of an excavation and provide protection to workers who may enter the excavation.

Strut means a horizontal cross-member of a shoring system that directly resists pressure from a wale or upright.

Support Structure means a shoring system required to maintain the stability of the walls and ceiling of an excavation and includes a trench cage.

Trench means an excavation having a depth which exceeds its width measured at the bottom.

Trench Cage means an approved steel support structure designed to resist the pressure from the walls of a trench and capable of being moved as a unit.

Trench Jack means a screw or hydraulic jack used as a brace in a shoring support structure.

Tunnel means a generally horizontal excavation more than 1 metre in length located below ground level.

Uprights means the vertical members of shoring that are placed up against and directly resist pressure from a wall of a trench.

Waler means a shoring member that is placed against and directly resists pressure from sheathing or uprights.

PART II

HAZARDS TO EXCAVATION WORKERS

- Why do serious injuries and fatalities to workers continue to occur in the excavation industry?

It is because both employers and workers often forget that when they remove earth from the ground, they are creating a situation where extreme pressures may be generated at the face of an excavation. There is no longer material available to support the walls of the excavation. Engineering controls must be utilized to provide a safe and healthy workplace within the excavation.

REMEMBER

- No one can predict accurately if an excavation is safe to enter without a proper support structure being provided.
- A worker does not have to be completely buried in soil to be seriously injured or killed. Workers who have been only buried up to their waist have died as a result of the pressures exerted by the soil on their bodies.
- Excavations in, or near, "back-filled" or previously excavated ground are especially dangerous since the soil is "loose" and does not support itself well.
- Water increases the possibility of a cave-in. The increased water pressure exerted on the soil can be the final factor in causing the walls to collapse.
- Clay can be extremely treacherous if dried by the sun. Large chunks of material can break off a trench wall after having been stable and solid for a long period of time.
- It is not safe to assume that because the walls of an excavation are frozen that it is safe to enter. Frozen ground is not an alternative to proper shoring.
- An excavation should be considered a confined space and appropriate evaluation and controls undertaken to ensure workers are not exposed to contaminated atmospheres.
- Shoring must be adequate to overcome additional pressures from piles of excavated material, adjoining structures, vehicular traffic, and nearby equipment.

PART III

WHAT TO DO PRIOR TO EXCAVATING?

1. MAKE SURE YOU ARE A REGISTERED CONTRACTOR

All employers undertaking excavation work are required to notify the Workplace Safety and Health Division and obtain a registration number. Once this number is obtained, the employer is considered a **registered excavation contractor.** If an employer is not performing excavation work safely, then a Safety and Health Officer may revoke the registration and the employer cannot do any more excavation work.

An employer may re-apply for registration, but must prove to the satisfaction of a Safety and Health Officer that he/she understands the requirements of the excavation regulation and will perform excavation work safely. Contact the Division if you are not registered!

2. NOTIFY THE DIVISION PRIOR TO EXCAVATING

Every excavator who intends to make a **trench excavation in excess of 1.8 metres** (6 feet) or an **open excavation exceeding 2.4 metres** (8 feet) in which a worker may enter must notify the Division not more than 48 hours prior to beginning the excavation. The Division will assign a serial number for that excavation.

The following information must be provided to the Division at the time of notification:

- the excavation contractor's registration number
- the name and address of the owner of the land where the proposed excavation is to be made
- the name and address of the employer, principal contractor, municipality, public utility, or agency of the government proposing to excavate
- the location of the proposed excavation and the date of the commencement of the work
- a description of the proposed depth, length, and width of the excavation
- a description of the proposed method of shoring, including the type of shoring materials to be used
- verification that the appropriate utilities have been notified and that the location of any pipes, conduits, or previous excavations in or adjacent to the proposed site has been determined and
- the name of the on-site worker supervising the excavation.

3. OBTAIN CLEARANCE FROM THE PUBLIC UTILITIES

Serious accidents have occurred in the past when excavators have made contact with a gas or energized electrical line causing fires, explosions, and injuries.

An excavation cannot be started until all the public utilities (including telephone, hydro, gas, steam, etc.) have been notified and the accurate location of all underground facilities has been determined.

If damage to any pipe, cable, or other underground facility occurs once the excavation has started, the employer must contact the utility **immediately** and advise them of the contact. No further excavation work should proceed until the utility has undertaken an on-site inspection. The workers must be evacuated from the worksite if an energized cable is exposed or dangerous fluids or gases are released.

> **Where a worker or any portion of excavating machinery or equipment may come closer than 3 metres (10 feet) to an overhead or underground electrical power line, the public utility must be contacted and permit authorization obtained.**

4. OBTAIN ENGINEERING APPROVALS

An employer must engage a professional engineer to provide design information and approvals for shoring support structures **where a worker or workers are required to enter an excavation:**

a) where a straight-cut trench excavation exceeds 4.5 metres (15 feet) in depth **or** 1.5 metres (5 feet) in width
b) where, in the opinion of a Safety and Health Officer, a shoring support structure is required to be designed due to the nature of the excavation or soil conditions
c) where a trench cage is to be used as a shoring support structure;
d) for all shaft and tunnel excavations
e) for all deep foundation (caisson, pile) excavations or
f) where the excavation may affect the structural integrity of an adjacent building, foundation, utility pole or other structure

5. PLAN FOR DANGEROUS CONDITIONS

A hazard assessment must be undertaken to determine the risks associated with workers entering an excavation. Possible hazards include:

a) explosive and toxic atmospheres
b) lack of oxygen
c) restricted access and egress
d) flooding
e) utility contacts (electrical, gas, steam, etc.) and
f) human factors (phobias, mental and physical conditions)

If a risk assessment reveals that there is a confined entry hazard in an excavation, then a proper work plan must be developed.

For example, in cases where a toxic or hazardous atmosphere may exist or could reasonably be expected to exist in an excavation, the employer must test the atmosphere and control worker exposure to the hazard. (For example, this may occur in excavations where there are accumulations of gasoline vapors due to leaking underground tanks. There are also situations where there may be elevated carbon monoxide (CO) levels or a lack of sufficient oxygen in the excavation.)

What to do:

1. The employer must test the atmosphere prior to entry into the excavation. If an unsafe atmosphere exists, ventilation must be provided to maintain safe working conditions.

2. If it is impossible to maintain a safe atmosphere by providing engineering controls and a worker must enter the excavation, then a proper supplied air respirator and emergency evacuation procedures must be provided.

3. If other hazardous conditions such as potential flooding of the excavation exist, then the employer must establish a safe working procedure. This may include provision of safety harnesses and lifelines to allow workers to be removed from the excavation immediately, should the hazardous condition develop.

(Refer to Workplace Safety and Support Services Division "Guidelines for Confined Entry Work" for more detailed information).

6. TRAIN THE WORKERS

An effective training program must be developed and delivered to excavation workers. Prior to a worker beginning excavation work, the employer must instruct each worker in proper and safe work procedures. This includes making the worker aware of the hazards associated with excavations and any emergency procedures or rescue methods that may have to be utilized.

7. APPOINT AN EXPERIENCED SUPERVISOR

The employer must ensure that an experienced and trained worker is designated to **directly** supervise each excavation project. This worker must be familiar with all aspects of excavation work, from shoring requirements to emergency rescue procedures. The supervisor must directly supervise all excavation work during the entire period the workers are in the excavation.

PART IV

GENERAL SHORING REQUIREMENTS

1. PERSONAL PROTECTIVE EQUIPMENT (PPE)

All workers doing excavation work must wear CSA approved Grade 1 safety footwear and safety headwear. Additional personal protective equipment may be required, depending on the risk assessment for the work to be undertaken (i.e. hearing protection, hand protection, etc.).

2. "OBSERVER" TO BE ON THE JOB

The employer is required to ensure that there is always an experienced worker designated to be the "observer" for trench excavations. This worker is responsible to remain on the surface and keep the trench and workers under observation for unsafe conditions.

3. PROVISION FOR ACCESS/EGRESS

A suitable means of access and egress must be provided for workers entering an excavation. This is usually provided by means of a ladder or stairway. Ladders must extend 1 metre (3 feet) above the top of the excavation. In a trench excavation, a ladder must be located within 3 metres (10 feet) of a worker's working position.

If workers are required to cross-over an excavation, then a proper walkway with suitable guardrails on all exposed sides must be provided.

4. LOCATION OF EXCAVATED MATERIALS & EQUIPMENT

All excavated materials must be piled in a manner so that the material cannot roll back into the excavation. The material must never be closer than 1 metre (3 feet) from the edge of the excavation, and should be placed as far away from the excavation as possible.

Tools, equipment, and heavy machinery shall not be placed or used near an excavation where they may fall into the excavation or affect the structural stability of the walls of the excavation.

5. PUBLIC PROTECTION & TRAFFIC CONTROL

All excavations, where the public has access, shall have a means provided to guard the public from the hazards of the excavation project. This includes barriers and signage to protect the public from falls, falling material, and excavating equipment. Proper covers or fencing must be provided to prevent the public from access to the excavation during "off" hours.

In public traffic areas, adequate signage and barricades meeting the requirements of the municipal or provincial highway authorities must be provided.

6. FIRST AID

First aid and emergency supplies must be kept at the excavation project at all times. It is recommended that at least one worker per shift be a trained first aider with CPR certification.

7. ENGINEERING INFORMATION

Engineered design specifications for shorting support structures, including trench cages, must be forwarded to the Division before using the structures, and made available at the excavation site to a Safety and Health Officer.

Design specifications shall include:

a) the size of the component members of the structure
b) the loads and types of soil conditions for which the the structure is designed
c) how the system is to be constructed and utilized

The employer is required to construct all shoring systems in accordance with the engineering design information provided.

PART V

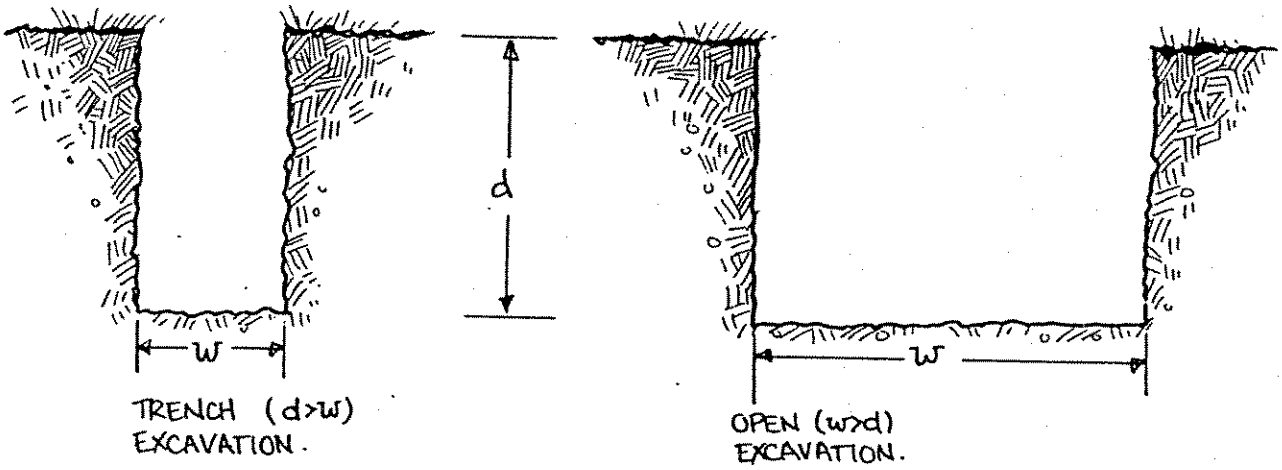
TRENCH AND OPEN EXCAVATIONS

Shoring, or the proper sloping of an excavation must be provided where a worker is to enter an excavation that is considered to be:

A. An open excavation exceeding 2.4 metres (8 feet) in depth. (An open excavation is any excavation that does not meet the criteria of being a trench, shaft, caisson, or tunnel)

OR

B. A trench excavation exceeding 1.8 metres (6 feet) in depth.



The shoring support structure must be designed to withstand all external forces that may be caused by:

a) soil pressures;
b) nearby structures;
c) additional loadings and vibrations (heavy equipment, traffic, piled materials near the excavation, etc.)

Unless approved by a professional engineer, shoring support structures must be installed so that they are in firm contact with the walls of the excavation. This may require backfilling of voids in the excavation up to the shoring support structure.

FROZEN GROUND IS NOT CONSIDERED AN ALTERNATIVE TO PROPER SHORING

1. TRENCH EXCAVATIONS

A. SOIL CATEGORIES

For purposes of establishing shoring tables for trench excavations, soils in Manitoba have been categorized into three main types:

Category I - **stiff and firm soils** - solid soils with substantial cohesion and no water table present. (i.e. good clay, stiff clay till, medium till)

Category II - **soils likely to crack or crumble** - soil that can be excavated by hand tools, show signs of cracking after excavating, and possess a low to medium moisture content (i.e heavily seamed silty clays, compacted clayey fill, and mixtures of clays and silts); and

Category III - **soft and loose soils** - soils easily excavated by hand with little or no cohesion (i.e. sand, gravel, silt, organic soil, soft and wet clay, and loose fill).

MANITOBA SOIL TYPES

The following is a list of soil types generally encountered in the Province of Manitoba:

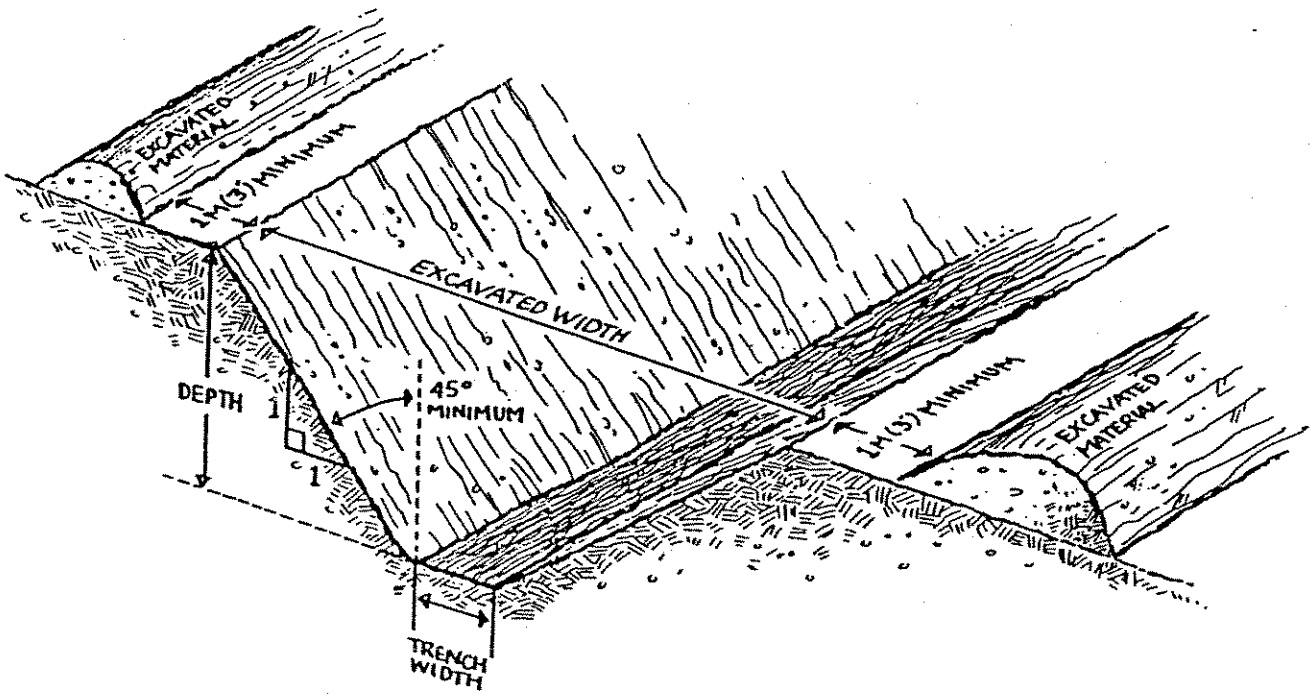
Peat and organic soil are generally wet and soft. They are usually encountered in a low lying flood plain or wetland areas.
Fill can be one or a mixture of different soil materials such as: silt, silty clay, sand and gravel, organic soil and rubble, etc. It can be hard, dense, loose, or soft.
Silt can be classified as cohesive or non-cohesive depending on the percentage of clay and sand content. It can be firm or soft in consistency. Upon saturation, it generally loses its strength and becomes unstable in a vertical cut.
Lacustrine silty clays are generally brown and grey in colour, medium to highly plastic and contain numerous silt and oxide inclusions, stones, and occasional pebbles. The silty clays generally have stiff to firm consistency and become softer with increased depth. In the top 10 to 15 feet, the silty clays generally are highly fissured and nuggety in structure. Upon saturation, the fissured silty clays usually become unstable in a vertical cut.
Sand and gravel can be classified as cohesionless material. These can be found in a dense or loose state.
Glacial till generally consists of clay, silt, sand, gravel stones, cobbles, and occasional boulders. Both soft and dense glacial till are common.
Limestone and granite bedrocks are found in Manitoba. They can be fractured or intact.

In general, the pore water pressure in the soil varies seasonally. Soil can become saturated by snow-melt or after a period of heavy precipitation. Silty clays and compacted clayey till at shallow depths are likely to be heavily fissured as a result of frost actions and desiccation. Fissured silty clays and clayey fill can have firm to stiff consistency in-situ. They are readily softened upon saturation and likely to crack or crumble. Loose silt, fill, sand and gravel, organic soil, and soft glacial till are readily weakened and have no strength upon saturation. Dense glacial till becomes soft upon saturation.

B. VEE-TYPE (SLOPED) EXCAVATIONS

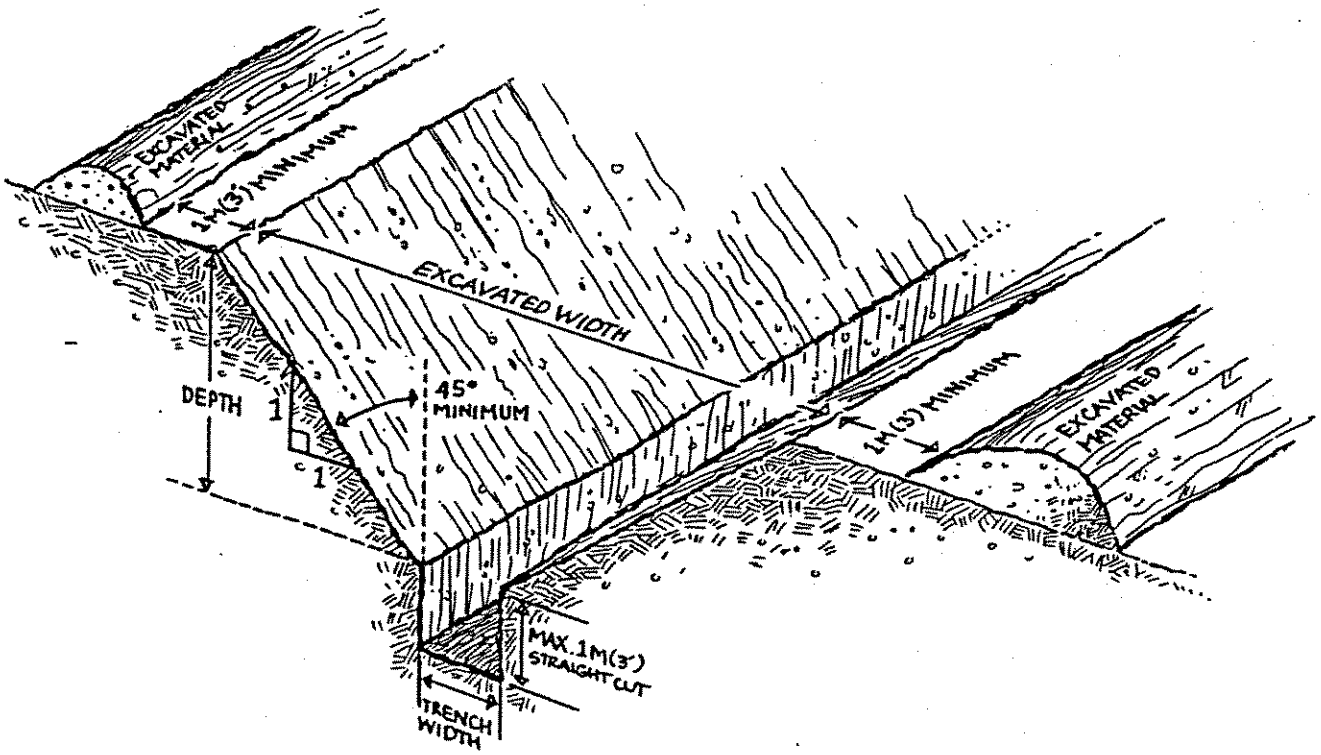
Instead of a shoring support structure, a safe method to protect workers in an excavation is to **slope the walls of the excavations at a grade of 1:1** (45°) or flatter. The 45° slope is required no matter what type of soil conditions exist.

FULLY SLOPED (VEE'D) EXCAVATION



A combination 1:1 (45°) slope and vertical face may be used, as long as the vertical face does not exceed 1 metre (3 feet) and the overall depth of the excavation is not greater than 5 metres (15 feet).

COMBINATION SLOPE AND VERTICAL FACE.



To calculate the overall width of a sloped excavation, use the following formula:

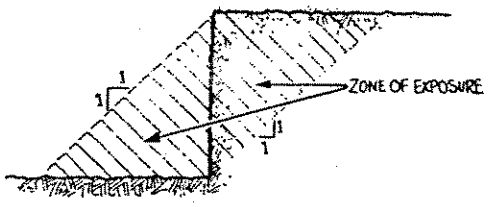
WIDTH = (2 X DEPTH) + BOTTOM TRENCH WIDTH

C. TYPE OF SHORING MATERIAL

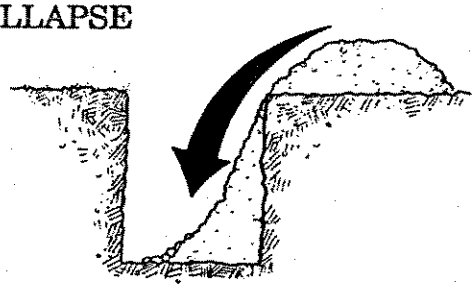
The majority of wood shoring used in trenches in Manitoba is comprised of full dimension poplar planks and timbers. Spruce lumber is also acceptable as shoring material provided it meets the shoring table requirements. The lumber must be construction grade No. 2 or better. Plywood used as sheathing material in loose soils must be a minimum of 20mm (3/4 inch).

Steel trench jacks may be used as struts, as long as they are equivalent in strength to the wood struts specified in the shoring tables. The longer dimension of the trench jack "foot" must be located perpendicular to the grain of the wood on the upright. (see diagram p.14.)

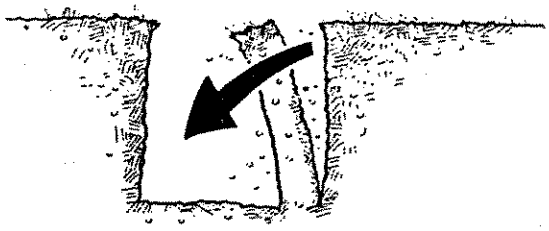
TYPES OF SOIL COLLAPSE



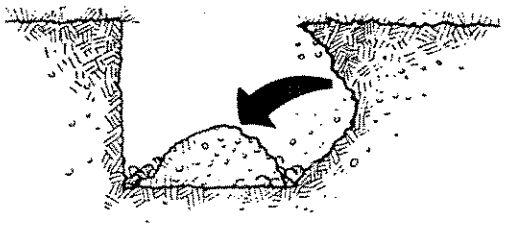
1) general zone of exposure - the area where workers are exposed to mass soil/rock movement.



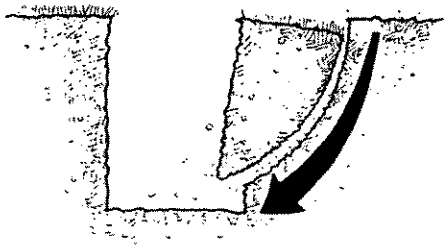
2) spoil pile slide - poor excavating procedures where the excavated material is not placed far enough away from the edge of the excavation



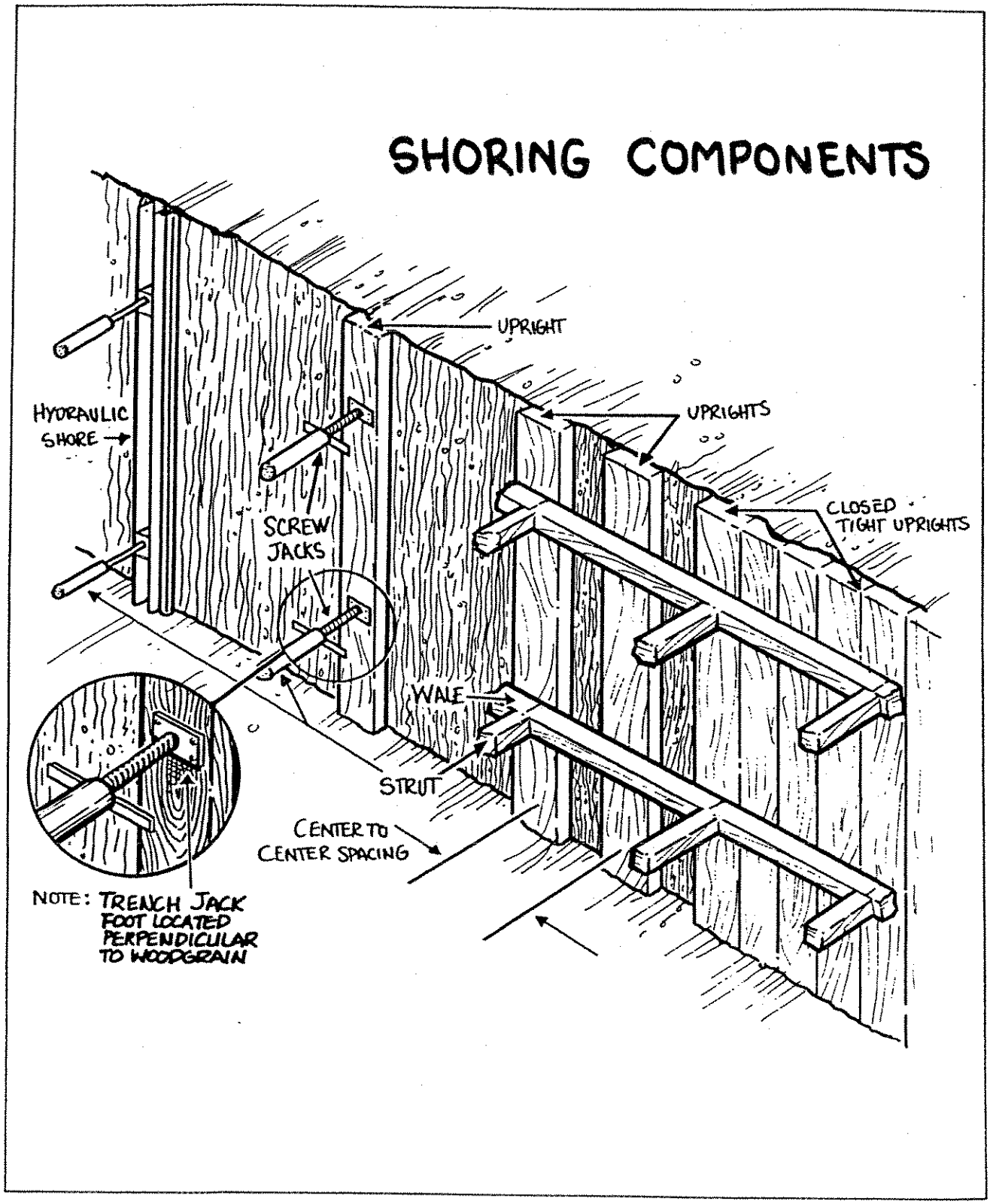
3) side wall shear - common to clay-type soils which are exposed to drying



4) slough-in (cave-in) - common to previously excavated material, sand and gravel mix



5) rotation - clay type soils when saturated with water


SHORING COMPONENTS
UPRIGHT
HYDRAULIC SHORE
UPRIGHTS
SCREW JACKS
CLOSED TIGHT UPRIGHTS
WALE
STRUT
CENTER TO CENTER SPACING
NOTE: TRENCH JACK FOOT LOCATED PERPENDICULAR TO WOODGRAIN

D. TRENCH SHORING TABLES

The shoring tables following indicate the allowable size and spacing of wood shoring for particular classifications of soil in Manitoba.

SIZE AND SPACING OF SHORING MEMBERS

FOR TRENCHES UP TO 60" WIDE

IMPERIAL UNITS

TRENCH DEPTH (FEET)	UPRIGHTS		STRUTS			WALES			
	MINIMUM DIMENSION (INCHES)	MAXIMUM SPACING (FEET)	MINIMUM DIMENSIONS (INCHES)	MAXIMUM SPACING (FEET) VERT	MAXIMUM SPACING (FEET) HORIZ	MINIMUM WALE DIMENSIONS (INCHES)	MAXIMUM VERTICAL WALE SPACING (FEET)	MAXIMUM HORIZONTAL STRUT SPACING (FEET)	MINIMUM STRUT DIMENSION (INCHES)
CATEGORY I - STIFF & FIRM SOILS (30 psf/ft.)									
0 - 10	2 X 8	3	4 X 4	4	3	6 X 8	4	6	4 X 6
10 - 15	2 X 8	2	4 X 4	3	2	6 X 10	3	6	4 X 6
CATEGORY II - SOILS LIKELY TO CRACK & CRUMBLE (50 psf/ft.)									
0 - 10	2 X 8	2	4 X 4	4	2	6 X 10	4	6	6 X 6
10 - 15	2 X 8	2	4 X 4	3	2	8 X 10	3	6	6 X 8
CATEGORY III - LOOSE & SOFT SOILS (75 psf/ft.)									
0 - 10	2 X 8	2	4 X 4	3	2	8 X 10	3	6	6 X 8

FOR TRENCHES UP TO 1.5 M

S.I. (METRIC) UNITS

TRENCH DEPTH (METRES)	UPRIGHTS		STRUTS			WALES			
	MINIMUM DIMENSION (MM)	MAXIMUM SPACING (METRES)	MINIMUM DIMENSIONS (MM)	MAXIMUM SPACING (METRES) VERT	MAXIMUM SPACING (METRES) HORIZ	MINIMUM WALE DIMENSIONS (MM)	MAXIMUM VERTICAL WALE SPACING (METRES)	MAXIMUM HORIZONTAL STRUT SPACING (METRES)	MINIMUM STRUT DIMENSION (MM)
CATEGORY I - STIFF & FIRM SOILS (4.71 kpa/m)									
0 - 3	38 X 191	0.9	89 X 89	1.2	0.9	140 X 191	1.2	1.8	89 X 140
3 - 4.5	38 X 191	0.6	89 X 89	0.9	0.6	140 X 235	1	1.8	89 X 140
CATEGORY II - SOILS LIKELY TO CRACK & CRUMBLE (7.85 kpa/m)									
0 - 3	38 X 191	0.6	89 X 89	1.2	0.6	140 X 235	1.2	1.8	140 X 140
3 - 4.5	38 X 191	0.6	89 X 89	0.9	0.6	191 X 235	1	1.8	140 X 191
CATEGORY III - LOOSE & SOFT SOILS (11.78 kpa/m)									
0 - 3	38 X 191	0.6	89 X 89	0.9	0.6	191 X 235	1	1.8	140 X 191

Important: see notes on next page

NOTES TO BE USED WITH TABLES & DIAGRAMS

1. Over 10' (3 m) in loose soils use vee trench not less than 45 ° from vertical or semi-vee with an approved trench cage.

2. Members must be at least SPF Species D, Aspen Species Group F, No. 2 Grade or better.

3. The above tables are based on graded nominal lumber dimension. Ungraded full dimension poplar is considered equal.

4. Trenches less than 5' (1.5 m) deep must be shored when dangerous ground movement is likely, as in ground subject to hydrostatic pressure or vibration.

5. At least two struts must be installed in each vertical plane where struts are required.

6. Steel trench jacks may be substituted for timber struts as follows:

IMPERIAL		METRIC	
Nominal Strut Size (inches)	Nominal Pipe I.D. Size (inches)	Nominal Strut Size (mm)	Nominal Pipe I.D. Size (mm)
4X4	1 1/2 Standard	89X89	40 Standard
4X6, 6X6	2 Standard	89X140, 140X140	50 Standard
6X8, 8X8	3 Standard	140X191, 191X191	75 Standard

The jacks must have a bearing area equal to the wood struts.

7. Shoring for sand and gravel (loose and soft soils) may be sized for soils likely to crack and crumble (50 psf/ft. or 7.85 kpa/m.)